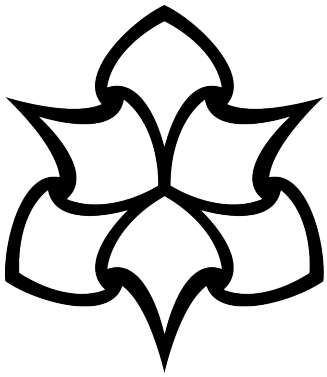

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Full length article

Unintended consequences of secondary legislation: A case study of the UK landfill tax (qualifying fines) order 2015

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ABSTRACT

Increasing attention is being paid to the use of policy instruments in promoting progressive waste management and supporting the transition to a circular economy. To be effective in this context, instruments must be balanced, providing the correct amount of sanction and incentive to ensure environmental protection, enhance resource recovery, and promote innovation and investment in beneficial technologies. Focusing on the UK landfill tax, and adopting a stakeholder-oriented approach, this paper presents a case study illustrating how the ineffective implementation of secondary legislation can have unintended consequences on the aims of primary legislation. Specifically, it examines the Landfill Tax (Qualifying Fines) Order 2015 (QFO), which introduced a Loss On Ignition (LOI) test regime to classify fines for tax purposes. Results from a stakeholder survey (n = 44) revealed that the introduction of the QFO has dis-incentivised material recovery and discouraged investment in separation technologies, thereby creating a perverse incentive to landfill waste. Major weaknesses identified include the poorly defined LOI test regime, the timing of and responsibility for conducting LOI testing, the lack of compliance checks, and the marked discontinuity in tax rates at the somewhat arbitrary 10% LOI threshold. Furthermore, the system was widely viewed to be open to abuse by unscrupulous traders. A set of recommendations are made to address these shortcomings, where it is proposed that the LOI threshold should be replaced by multiple tax bands or a sliding scale and ideally combined with a direct incentive for investment such as an enhanced capital allowance for resource efficient technologies.

1. Introduction

Transitioning from a linear to a Circular Economy (CE) could overcome consequences of unsustainable consumption such as environmental degradation, resource depletion, and climate change (Moreno et al., 2016). A CE mimics a natural biological system by recirculating resources through successive generations, where resource efficiency is promoted through the optimisation of production systems, resource utility is maintained by extracting the maximum value when in use, and any remaining value at end-of-life is recovered through progressive waste management strategies (Smol et al., 2015).

There is now growing attention on the role of policy in delivering the CE. Soderman et al. (2016) notes that the European Union (EU) is increasingly recognising the role of policy in supporting the transition from end-of-pipe waste management to efficient resource management, whilst Jimenez-Rivero and Garcia-Navarro (2017) highlight the need for government to strengthen and enforce instruments that adhere to CE principles. One CE-aligned approach is the use of Extended Producer Responsibility (EPR), which places responsibility for end-of-life management with the producer (Lindhqvist, 2000). Currently the use of EPR (in the EU and elsewhere, e.g. Mrkajić et al., 2018; Wang et al., 2018) is restricted at a practical level to packaging waste, waste electrical and electronic equipment, end-of-life vehicles, and hazardous household wastes (Lifset et al., 2013). For an ideal CE approach, this would extend to up-stream issues such as eco-design, along with full internalisation of waste management costs to shift responsibility from taxpayers and local authorities to companies and consumers (Lifset et al., 2013). While this may be realised in the future, during the transition end-of-pipe waste management remains a key concern. Indeed, EU policy initiatives, the most recent being the 'Circular Economy Package (CEP)' (2015-ongoing; European Commission EC, 2016), place an increased emphasis on both CE models and the efficient use of wastes (Gregson et al., 2015; Smol et al., 2015).

With respect to waste management, two key EU directives are the Waste Framework Directive (WFD) (2008/98/EC), which introduces the waste hierarchy and sets recycling targets, and the Landfill Directive (LD) (1999/31/EC), which sets targets requiring a reduction in the landfilling of biodegradable and other polluting solid wastes

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(European Commission EC, 2008, 1999). Both the WFD and the LD have been amended by the CEP, which reiterates the waste hierarchy, strengthens recycling targets, and extends landfill diversion targets to include all municipal wastes (European Commission EC, 2015a,b).

Although all member states are obliged to transpose EU directives into national policy, economic and social differences between countries are reflected in the disparity of waste management systems employed (Mihai and Apostol, 2012; Pires et al., 2011). Concerning landfill diversion, several countries have achieved very low landfilling rates, where this has been attributed to effective national policy and the use of fiscal measures such as Landfill Taxes (LFTs) (European Environment Agency EEA, 2000; Mazzanti et al., 2009).

While LFTs have been successful in diverting waste from landfill, to what extent they promote material recovery is less clear. The financial competitiveness of secondary materials can be enhanced through taxation on competing virgin materials or on waste disposal, where Solderholm (2011) argues that the latter can be more effective due to low administration costs and increased policy acceptance. However, Martin and Scott (2003) found that while the United Kingdom (UK) LFT had increased landfill diversion, it had been less successful in promoting the top waste hierarchy priorities. Likewise, in an EU-wide study, Mazzanti and Zoboli (2008) concluded that while LFTs can lead to the management of waste being promoted up the waste hierarchy (to recovery or recycling), they do not create a backwards incentive to reduce waste generation. To address such issues, researchers have called for a re-framing of the waste hierarchy in terms of resource use and productivity, arguing that this would help policy makers ensure that they not only disincentivise disposal, but also adequately incentivise preferred environmental options (Gharfalkar et al., 2015; Van Ewijk and Stegemann, 2014).

Another factor that requires consideration is the evolution of policy instruments in response to technological advancements in waste processing, with particular attention paid to the interaction between the negative externalities of pollution and the positive externalities of technological innovation (Leme et al., 2014; Luz et al., 2015). Jaffe et al. (2003) argue that policies targeting pollution reduction should also support technological change. Thus, there is a case for combining environmental taxes with direct incentives if the signal from a single instrument is insufficient to promote innovation and adoption of beneficial technologies (Jaffe et al., 2005). Likewise, Bennear and Stavins (2007) argue that in such “second-best” settings, which are common in the area of environmental and resource management, the use of multiple instruments is both the norm and justifiable. However, they also caution that this requires a high level of policy coordination, which may extend to an instrument designed to address one issue being modified in light of another to achieve an overall positive outcome (Bennear and Stavins, 2007).

While the design of appropriate policy instruments is clearly important, it is equally important to ensure the desired impact is achieved through effective implementation (Soderman et al., 2016). In this context, Bailey and Rupp (2005) contend that implementation cannot be fully understood or improved without due consideration of stakeholder perspectives, arguing that industry is uniquely placed to make a valuable contribution towards understanding the strengths and weaknesses of environmental policy instruments. Indeed, numerous stakeholder-related factors have been identified that could undermine implementation, including a lack of competent staff, ineffective administrative capabilities, incoherent or uncomprehensive written documentation, poor inter-organisational communication and support, a lack of cooperation, and competing priorities (Bailey and Rupp, 2005; Khan and Khandaker, 2016; Mosannenzadeh et al., 2017; McTigue et al., 2018). In relation to the latter point, Bailey and Rupp (2005) found that eco-taxes may be counter-productive if a reduction in profitability leads to the de-prioritisation of environmental issues. This again highlights the need to find a balance between competing priorities (or multiple market failures) in waste management policy in order to encourage development of optimal systems. Otherwise, under-regulation may lead to the careless handling of wastes, while over-regulation, regulation that is unclear, or an absence of compensatory incentives, may hinder the re-use of waste materials by creating excessive bureaucracy and stifling innovation (Gharfalkar et al., 2015; Jaffe et al., 2005).

This paper presents a case study illustrating how the ineffective implementation of secondary legislation can have unintended consequences on achieving the aims of primary legislation. Focusing on the UK LFT, it employs a stakeholder survey to examine how the introduction of the Landfill Tax (Qualifying Fines) Order 2015 (QFO) (House of Commons HoC, 2015), a statutory instrument used to classify waste, has impacted on stakeholders. Expanding on a preliminary analysis (Fletcher et al., 2017) it examines how the QFO may disincentivise material recovery and thereby limit landfill diversion, where consideration is given to potential modifications that would ensure sufficient environmental protection while enhancing the economic viability of waste processing. The paper is structured as follows. Section 2 outlines the development of the UK LFT and QFO. Section 3 details the methods used to conduct the analysis. Section 4 discusses stakeholder views on the design and implementation of the QFO, highlighting barriers to material recovery and landfill diversion, and suggesting potential policy developments. Finally, Section 5 reviews the wider implications and conclusions of the study.

2. The UK landfill tax

The UK LFT facilitates the implementation of the LD (Calaf-Forn et al., 2014; Morris et al., 2000), and was introduced in the 1996 Finance Act (HM Stationary Office HMSO, 1996) and modified in the Landfill Tax (Amendment) Regulation 2009 (HM Stationary Office HMSO, 2009). A regulatory incentive administrated by Her Majesty’s Revenue and Customs (HMRC), the LFT applies differential tax rates to wastes disposed of to landfill in order to reflect the environmental burden of this disposal option (Calaf-Forn et al., 2014; Grigg and Read, 2001; Morris et al., 2000). It defines inert (or inactive) waste, which qualifies for a lower tax rate, as non-hazardous (as described by the WFD), with a low Greenhouse Gas (GHG) emission potential (not biodegradable) and low polluting potential (contaminants unlikely to become mobile or leach). Any waste that does not conform to these criteria is classed as active and is liable for the standard tax rate (HMRC, 2016a). In accordance with Section 42(2) of the Finance Act 1996(a), a definitive list of materials that were deemed to meet the definition of inert waste (for the purposes of setting the LFT rate, and based on well characterised properties) was published. Originally delivered through the Landfill Tax (Qualifying Materials) Order 1996 (QMO) and updated in 2011, the materials listed include; naturally occurring materials (rocks, sand and soils), low activity processed materials (glass, ceramics or concrete), processed or prepared minerals (silica, mica or clay), furnace slags, ash, low activity inorganic compounds, calcium sulphate, and calcium hydroxide (including brine) (House of Commons HoC, 2011, 1996).

When first introduced, the LFT rates were £2/tonne for inert waste and £7/tonne for active waste, thus with gate fees of around £5–£15 (ENDS, 1994) total disposal costs remained relatively low. As such, the LFT provided little financial incentive for diversion and had minimal effect on the amount of waste being disposed to landfill (Martin and Scott, 2003). To address this legislative failure, the LFT escalator was introduced (HM Treasury, 1999; Martin and Scott, 2003), where the price of landfilling active waste increased by a fixed amount each year from 2000 to 2014. Since 2015, both the active and inert tax rates have been index linked (HMRC, 2016b), standing at £84.40/tonne for active waste and £2.65/tonne for inert waste in 2016/17 (HMRC, 2016a). Although gate fees have also increased (partly reflecting improved landfill management practices) they have been relatively stable since 2008, with a mean of £22/tonne in 2016 (The Waste and Resources

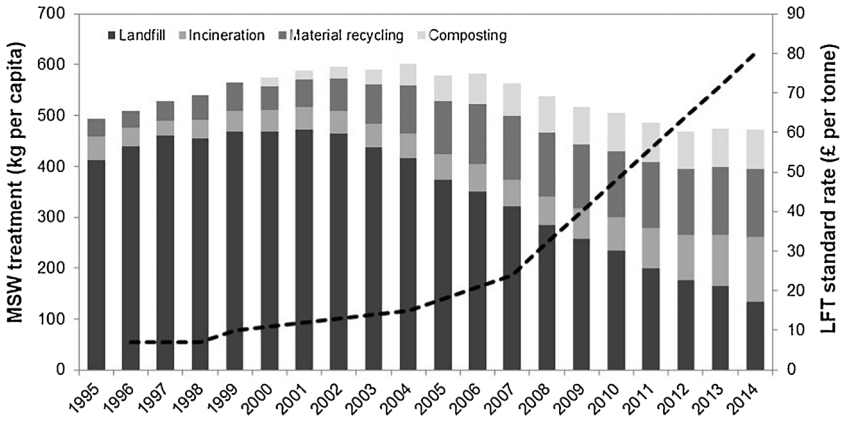

Fig. 1. Impact of the UK landfill tax on the management of Municipal Solid Waste. The landfill tax liability for standard-rated materials is from HMRC (2016a). Waste management data are from Eurostat (2016).

Action Programme WRAP, 2009, 2017). Thus, for active waste the tax liability now clearly exceeds other disposal costs, and the total disposal cost (around £106/tonne) is considerably higher than that for inert waste (around £25/tonne).

The LFT is applied to all non-exempt wastes, with the standard rate typically applied to Municipal Solid Waste (MSW) and hazardous waste, and the lower rate typically applied to Construction and Demolition (C &D) waste (Conran, 2017). While sufficient data is not available to assess the impact of the LFT on all waste streams, it is available for MSW (Fig. 1), where it can be seen that the LFT escalator incentivised a dramatic reduction in landfilling of around 50% between 2000 and 2013, with a concomitant fivefold increase in other waste treatment methods (Eurostat, 2016; HMRC, 2016a). Indeed, in the management of MSW the removal of recyclable materials, such as glass, high-grade plastics and metals, is now routine (Beccali et al., 2001; Santibanez-Aguilar et al., 2013). Likewise, combustibles (e.g. low-grade plastics and textiles) are often separated and used as refuse derived fuel (Násner et al., 2017; Vountatsos et al., 2016), while biodegradable materials (e.g. food and garden wastes) are often removed and composted or used in energy generation (Santibanez-Aguilar et al., 2013). This has been achieved through source segregation and more recently through technological separation at mechanical biological treatment and material recovery facilities (Cook et al., 2015; Vountatsos et al., 2016), where such approaches are also employed in the management of C&D and other wastes. While advanced processing methods have delivered gains in material and energy recovery, they have not delivered (and cannot deliver) full recovery, where landfill disposal remains the preferred option for residual waste streams (Beccali et al., 2001; Santibanez-Aguilar et al., 2013). Thus, in addition to a reduction in the amount of landfilled waste, another consequence of technological advancement has been a change in the nature of wastes sent to landfill, with an increasing contribution from 'fines' (the small fragments that remain after processing via a mechanical treatment such as trommel screens, HMRC, 2016a). As the composition of fines is highly variable, being dependent on both the composition of the input waste and the separation techniques employed (Dias et al., 2012), this change in the nature of landfilled waste has given rise to a key question regarding the classification of fines as either active or inactive.

As fines are often processed from a mixed waste (and therefore contain a mixture of materials), even those arising from waste streams dominated by inert materials (e.g. C&D waste) may not consist of qualifying materials (listed as inert in the QMO) in their entirety (Balch, 2014). While the QMO does make allowance for the presence of a 'small' amount of active waste, known as 'incidentals', what constitutes a small amount is not clearly defined. Indeed, only generic guidance is provided, that "whether an amount of standard-rated waste [i.e. active waste that is liable for the standard tax rate] is small will depend on the circumstances and is a matter of fact and degree. As a guide, the dictionary definition of small is either small in size or weight, or insignificant or unimportant" (HMRC, 2016a). Thus, in the absence of a clear definition, what emerged in practice was a relatively informal system, where the responsibility of determining whether an amount of incidental material qualified as small rested with the landfill operator (HMRC, 2016a). As such, the classification of fines has been strongly debated within the waste industry, with concerns that the lower rate of tax was not being applied equitably and that more clarity was required concerning liability (Balch, 2014; Goulding, 2015a,b).

To address these concerns, the waste industry was consulted on proposed secondary legislation to use a standardised Loss On Ignition (LOI) test to classify fines where an LOI of 10% or less would indicate inert material with a 'small' amount of contamination (HMRC, 2014a). Overall, respondents agreed with the proposal, but raised concerns regarding conformity of fines to the QMO, time required for businesses to adjust, the 10% LOI limit, and operational aspects of the LOI test (HMRC, 2014b). A number of revisions were made in response, including a prescribed LOI testing regime, and the QFO was introduced where responsibility and liability for implementation was placed primarily with the landfill operator, but where correct classification of fines was also dependent on information provided by the waste processor (Fig. 2).

While the QFO provided a degree of clarity on the classification of fines, debate continued regarding the economic and practical realities of implementation (Balch, 2014; Coll, 2015). The QFO has seen some materials that may have qualified as inert (based on the QMO and the interpretation of a 'small' amount of incidentals) now classed as active waste unless proven otherwise, creating uncertainty and scepticism amongst operators (Balch, 2014; Coll, 2015). Furthermore, while the QFO has encouraged further material recovery in some cases (e.g. removal of metal fragments from C&D derived fines to reduce the total weight of fines sent to landfill), it has been suggested that in other cases it may reduce the financial viability of recycling operations, thereby acting contrary to the intended incentive (Coll, 2015).

These issues are further compounded by concerns regarding the reliability of the LOI test regime (Goulding, 2016, 2015a,b). While the prescribed sampling method attempts to homogenise loads, Goulding (2015a,b) has provided anecdotal evidence that it can be manipulated. Similarly, Goulding (2016, 2015a) cites concerns raised by test providers regarding differing interpretation of the LOI test method and the consistency of data produced.

3. Materials and methods

Considering the ongoing areas of debate regarding the QFO, a survey of waste management stakeholders was conducted to solicit

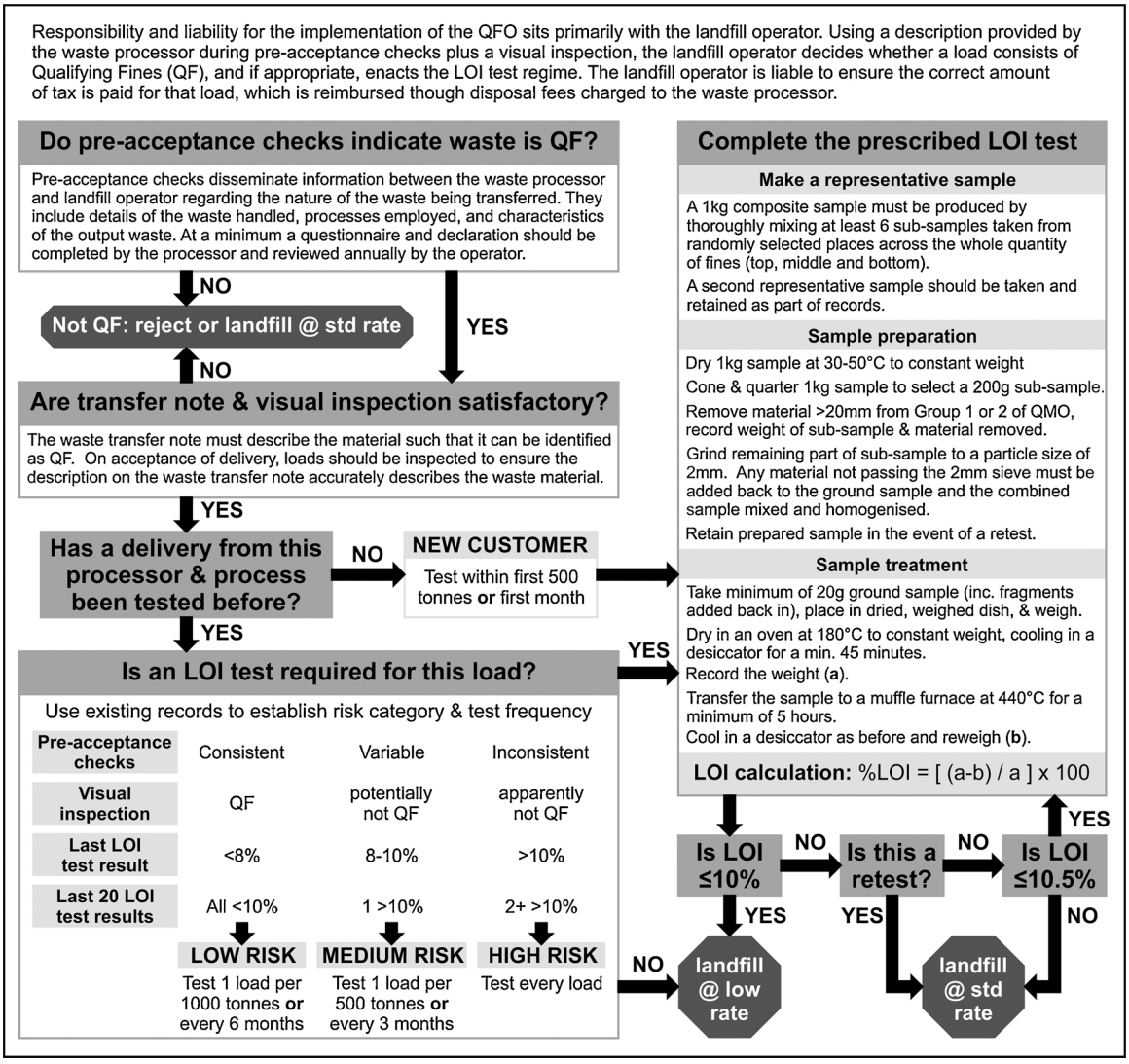

Fig. 2. The process for determining the appropriate landfill tax rate for residual fines in accordance with the Landfill Tax (Qualifying Fines) Order 2015. Based on the guidance provided by HMRC (2016a).

views on the implementation of the QFO with a focus on the LOI testing regime. Specifically, the survey sought to ascertain opinions regarding previously identified issues and potential proposed solutions in order to inform recommendations for policy development.

The survey instrument was an online self-administered questionnaire created and published using SurveyMonkey (see Appendix A1 in Supplementary material for a full copy). Questionnaire development was informed by industry literature (Balch, 2014; Coll, 2015; Goulding, 2016, 2015a,b) and discussions on fines management at an open meeting hosted by the Chartered Institute for Waste Managers (CIWM) on 4th March 2016 at the Cotton Exchange, Liverpool, UK. Key issues identified included impacts on workplace resource requirements (Balch, 2014; Coll, 2015), a lack of support for implementation, and poor reliability of the testing regime (Goulding, 2016; 2015a,b). These points were reiterated at the CIWM meeting, where a number of potential modifications were also proposed, including the introduction of additional tax bands or spike allowances, laboratory accreditation, and third-party sampling.

A qualifying question was employed to ensure only stakeholders whose work related to or was impacted by the LOI testing regime proceeded. To enable categorisation of responses by stakeholder groups, qualifying respondents were first asked questions regarding their sector and the nature of their connection to the production, management, or testing of fines. This was followed by questions addressing the perceived impact of the LOI testing regime on workplace resource requirements, opinions regarding issues identified with the LOI testing regime, and opinions regarding the proposed potential modifications.

The questionnaire employed closed questions with optional open comment boxes to instigate elaboration. Opinions were measured using Likert-type rating scales (Likert, 1932), where the response format was selected to minimise the risk of introducing bias and followed the recommendation of Revilla et al. (2014) to employ a five point fully labelled scale with a neutral midpoint for opinion measurement in the general population. To ensure respondents were not forced to specify an opinion, thereby introducing a response bias (Friedman and Amoo, 1999), 'don't know' and 'not applicable' (N/A) options were also included. While such responses are commonly excluded from analysis, doing so without consideration of potential consequences can lead to biased results and lost information (Kroh, 2006; Wang, 1997). Here all 'don't know' and the majority of 'N/A' responses were considered to reflect either a genuine lack of knowledge on the subject and/or cases where the topic did not apply to the respondent, and were excluded. However, 'N/A' responses regarding the impact of the LOI testing regime on resource requirements were retained and treated as equivalent to a neutral response.

An invitation to participate was sent to 311 individual email addresses, comprising 27 CIWM meeting delegates and 294 addresses identified from web searches for waste management organisations (within a 15-mile radius of 24 UK urbanisations), commercial laboratories offering LOI testing, and waste research groups. The questionnaire link, with accompanying invitation, was also featured in the CIWM newsletter, Skip Hire magazine, and member communications of the United Resource Operatives Consortium. The invitation informed respondents about the purpose of the study, anonymity of responses, and intended publication of results with key recommendations. To enhance response rates an incentive was offered, whereby respondents could opt in to a prize draw. In total 44 complete responses were received in the period 9th June to 1st August 2016. This is consistent with similar surveys within waste management, which have received 12–35 responses (Eskandari et al., 2012; Glew et al., 2013).

Quantitative data from the closed questions were analysed using Microsoft Excel 2013 and SPSS (v.22) to produce frequency distributions and to test for differences between stakeholder groups. There is marked variation in practice and debate in the literature regarding the appropriate statistical analysis of Likert-type data (Bishop and Herron, 2015; Carifio and Perla, 2008; Jamieson, 2004). As this study is exploratory in nature, with analysis carried out at the level of individual questions, a conservative approach was adopted and the data was treated as ordinal, with the nonparametric Pearson's Chi-Square (X^2) statistic used to test for differences between groups (Jamieson, 2004; McHugh, 2012). Unless otherwise stated, differences between groups were insignificant. Qualitative data (comments from open comment boxes) were used to enrich the quantitative responses and to identify areas of agreement and conflict.

4. Results and discussion

4.1. Respondent profile

Table 1 presents a breakdown of respondents categorised by organisation type and connection to the LOI testing regime. Of the 30 respondents who provided their job title, all held managerial or professional positions (Office of National Statistics, ONS, 2010). Overall, the respondent profile demonstrates that expert opinion from within the waste industry and associated sectors contributed to the survey, indicating good representation for the results.

4.2. Workplace resource requirements

Two-thirds of respondents reported some increase in resource requirements when the LOI testing regime was introduced, where the most frequently cited were an increased time requirement and paperwork burden. Group 1 were significantly more impacted than group 2, reflecting their direct engagement in the management of fines (Table 2).

Around two-fifths of respondents reported an increase in financial resource requirements, including capital expenditure and/or

Table 1
Respondent profile categorised according to their connection to the management of fines.

Group 1: Direct connection (n = 27) *Production and disposal of fines*	Group 2: Indirect connection (n = 17) *Policy development & regulation, auxiliary services, research.*
Waste processing (16) Landfill operation (5) Internal policy compliance (6)	Policy development & regulation (4) Waste consultancy (4) Test provider (6) Waste machinery supplier (1) Academic research (2)

Table 2
Respondent opinion regarding the impact of the LOI testing regime on workplace resource requirements. Significant differences in responses between groups are highlighted.

	All Respondents					Group 1: Direct Connection					Group 2: Indirect Connection					Chi-squared test Group 1 v Group 2		
Workplace Aspect	Large increase # (%)	Small increase # (%)	Neutral # (%)	Small decrease # (%)	Large decrease # (%)	Large increase # (%)	Small increase # (%)	Neutral # (%)	Small decrease # (%)	Large decrease # (%)	Large increase # (%)	Small increase # (%)	Neutral # (%)	Small decrease # (%)	Large decrease # (%)	X^2	df	P-value
Time allocation	6 (14%)	23 (52%)	15 (34%)	0 (0%)	0 (0%)	5 (19%)	18 (67%)	4 (15%)	0 (0%)	0 (0%)	1 (6%)	5 (29%)	11 (65%)	0 (0%)	0 (0%)	11.6	2	**0.003**
Paperwork	5 (11%)	20 (45%)	19 (43%)	0 (0%)	0 (0%)	5 (19%)	18 (67%)	4 (15%)	0 (0%)	0 (0%)	0 (0%)	2 (12%)	15 (88%)	0 (0%)	0 (0%)	23.1	2	**0.000**
Capital expenditure	7 (17%)	9 (21%)	26 (62%)	0 (0%)	0 (0%)	6 (24%)	8 (32%)	11 (44%)	0 (0%)	0 (0%)	1 (6%)	1 (6%)	15 (88%)	0 (0%)	0 (0%)	7.26	2	0.270
Operational costs	8 (20%)	6 (15%)	27 (66%)	0 (0%)	0 (0%)	6 (25%)	6 (25%)	12 (50%)	0 (0%)	0 (0%)	2 (12%)	0 (0%)	15 (88%)	0 (0%)	0 (0%)	7.35	2	**0.025**
Staff numbers	1 (2%)	5 (12%)	37 (86%)	0 (0%)	0 (0%)	1 (4%)	4 (15%)	21 (18%)	0 (0%)	0 (0%)	0 (0%)	1 (6%)	16 (94%)	0 (0%)	0 (0%)	1.67	2	0.435
Maximum impact for any aspect	11 (30%)	18 (49%)	8 (22%)	0 (0%)	0 (0%)	9 (36%)	14 (56%)	2 (8%)	0 (0%)	0 (0%)	2 (17%)	4 (33%)	6 (50%)	0 (0%)	0 (0%)	8.49	2	**0.014**

operational costs. One respondent who identified a neutral impact on capital expenditure noted that it might be required in the future, but "until the problems relating to variability and accuracy of testing can be overcome, the type and level of expenditure cannot be determined."

While, six respondents reported an increase in staff requirements, one respondent highlighted a potential negative impact on future employment. Here, the 'huge' increase in operational expenditure was leading a private waste management company to evaluate the financial viability of their sorting stations, where the absence of tax savings in combination with the low value of separated materials results could lead to the plants becoming redundant.

4.3. The 10% LOI threshold

The current 10% LOI limit sets the threshold between the low and standard tax rates. When asked whether they thought the 10% LOI limit appropriately represented the characteristics of an inert waste, less than half (14) of the respondents (n = 33) agreed. Five respondents (all from group 1) thought it was too low, citing concerns related to the definition of qualifying fines. Eight respondents (from both groups) thought it was too high, noting that fines with 10% LOI "can still generate significant amounts of GHG". Of the six respondents who cited other reasons, half highlighted that it focused solely on GHG emissions taking no account of other factors that influence toxicity or odour potential. Others noted that it appeared to penalise recycling and recovery, where the marked step in tax liabilities at the threshold was viewed as punitive and failing to reflect the efforts made by operators to improve waste treatment.

4.3.1. Proposed modifications to the 10% LOI threshold

Respondents' views on four potential modifications to the 10% LOI threshold are presented in Table 3A.

Proposals to either increase or decrease the current threshold were not widely supported, with around four-fifths of respondents giving a neutral or negative response. Not unexpectedly, support for these proposals mirrored views on the appropriateness of the threshold, with those who considered it to be too low or too high favouring an increase or decrease respectively.

Proposals to replace the sharp threshold with banding (where one or more additional tax brackets are introduced for fines with intermediate LOI) received a mixed response. Around half of the respondents supported the addition of one extra band, with around a third opposed, and a sixth neutral. Overall support for multiple bands was somewhat lower, with a broadly even split between supportive, opposing, and neutral responses. However, there were significant differences between the groups, where group 1 supported multiple bands and group 2 opposed.

Group 1 viewed banding as a means of removing the perceived disincentives to material recovery arguing that banding would strengthen the economic viability of processing operations, and with one respondent suggesting a sliding tax scale (with an increase in tax rate on the order of £5 for each percentage point above the threshold) would be a preferred solution.

For the most part, group 2 did not oppose the principle of banding, but held concerns regarding the ability to implement it. Respondents noted that the LOI test is neither precise nor accurate enough to support banding, and identified specific issues with the methodology (e.g. missing details regarding vessel size, and depth/surface area of the sample) that further contributed to a high variation in test results within and between laboratories. Indeed, a number of respondents highlighted that this variation (reported to be around 2%) leads the current regime (under which significant additional cost is incurred if the LOI test result is 0.1% over the threshold) to be perceived as unfair, and suggested that the tax threshold should reflect this (un)reliability, potentially through inclusion of an allowable measurement error.

4.4. Frequency of fines testing

Test frequency is dependent on previous performance, taking into account consistency of pre-acceptance checks, outcome of visual inspections, and prior LOI results. Respondents were asked to what extent they agreed that; (1) the test regime is very clear and the testing frequency is easy to determine, and (2) the risk categories used to determine testing frequency are fair (Table 3B).

Around a third of respondents considered the method to be unclear and/or unfair. Concerns were related to the practicability of the test regime due to the size of operations and the time delays between delivery of waste to site and receiving test results. Respondents also highlighted that the current regime is open to abuse, indicating that some operators may discard test results to avoid moving into higher risk categories (thereby avoiding higher test frequencies and associated costs).

4.4.1. Proposed modifications to determination of test frequency

Respondents views on four potential modifications to the method for determining test frequency are presented in Table 3C. Only the introduction of a spike allowance received wide support, with less than a third of respondents supporting the other suggestions.

While it was acknowledged that a fixed number of tests would be simpler, respondents also noted that it could lead to an increased overall burden. The risk that a prescribed test schedule would be open to abuse (e.g. through the provision of compliant but atypical samples) was also identified, with one respondent noting "huge savings could be made from bad practice".

Proposals to either increase or decrease the number of risk categories received the least support, where respondents highlighted that the use of risk categories (even those established) was unworkable due to the inherent variability of the materials, length of time required to test a sample, and the poor accuracy and precision of the test.

Around four-fifths of respondents supported the introduction of a spike allowance, with stronger support (and no opposition) from group. One opposing respondent from group 2 noted that the introduction of spike allowances would defeat the object of the LOI testing regime. However, a respondent from group 1 suggested that a constrained spike allowance could be built into risk categories, where they considered it would be reasonable to suggest fines remained in the lower risk category if one in ten samples spiked over 10% by no more than 2% (the reported level of variation in the accuracy of the LOI test).

4.5. Support for implementation of the LOI testing regime

When asked their views regarding current support for implementation of the LOI testing regime, more than half of the respondents reported that the support was inadequate, with less than a fifth finding the support adequate (Table 4A). Dissatisfaction was higher in group 1, with a clear majority reporting inadequate support. These respondents perceived a lack of expertise within HMRC regarding the waste industry and waste related taxes, citing the advocacy of a poorly defined test method. Furthermore, some respondents considered that landfilling of waste was effectively "unpoliced", thereby enabling "cowboy operators" (a term used to refer to dishonest or unscrupulous operators) to falsely describe material in order to send it to landfill as inert. To address this issue, one respondent suggested that the HMRC should take the lead in testing more sites to ensure compliance and consistency.

4.5.1. Proposed modifications to support for implementation

Respondents' views on six potential modifications to enhance the support provided for implementation of the LOI testing regime are presented in Table 4B.

The majority of respondents agreed that further support from HMRC would be of a benefit. However, one respondent stated that the

Table 3
Respondent opinion regarding LOI limit and testing frequency. Significant differences in responses between groups are highlighted.

	All Respondents					Group 1: Direct Connection					Group 2: Indirect Connection					Chi-squared test Group 1 vs Group 2		
	Strongly agree # (%)	Agree # (%)	Neutral # (%)	Disagree # (%)	Strongly disagree # (%)	Strongly agree # (%)	Agree # (%)	Neutral # (%)	Disagree # (%)	Strongly disagree # (%)	Strongly agree # (%)	Agree # (%)	Neutral # (%)	Disagree # (%)	Strongly disagree # (%)	X^2	df	P-value
A. Views on potential modifications to the 10% LOI limit																		
Increase the LOI limit	4 (11%)	3 (8%)	15 (42%)	9 (25%)	5 (14%)	4 (27%)	3 (20%)	5 (33%)	3 (20%)	0 (0%)	0 (0%)	0 (0%)	10 (48%)	6 (29%)	5 (24%)	5.95	4	0.203
Decrease the LOI limit	4 (11%)	3 (8%)	13 (35%)	9 (24%)	8 (22%)	2 (11%)	1 (5%)	2 (11%)	7 (37%)	7 (37%)	2 (11%)	2 (11%)	11 (61%)	2 (11%)	1 (6%)	9.36	4	0.053
One additional tax band	3 (8%)	16 (43%)	6 (16%)	6 (16%)	6 (16%)	1 (6%)	11 (61%)	3 (17%)	2 (11%)	1 (6%)	2 (11%)	5 (26%)	3 (16%)	4 (21%)	5 (26%)	7.38	4	0.117
Multiple additional tax bands	8 (22%)	4 (11%)	11 (30%)	8 (22%)	6 (16%)	7 (39%)	4 (22%)	4 (22%)	2 (11%)	1 (6%)	1 (5%)	0 (0%)	7 (37%)	6 (32%)	5 (26%)	10.2	4	**0.037**
B. Views on the current method to determine test frequency																		
The test regime is clear	1 (3%)	16 (41%)	11 (28%)	8 (21%)	3 (8%)	1 (5%)	7 (33%)	6 (29%)	5 (24%)	2 (10%)	0 (0%)	9 (50%)	5 (28%)	3 (17%)	1 (6%)	0.98	4	0.912
The test regime is fair	1 (3%)	11 (29%)	13 (34%)	6 (16%)	7 (18%)	1 (5%)	3 (14%)	7 (33%)	5 (24%)	5 (24%)	0 (0%)	8 (47%)	6 (35%)	1 (6%)	2 (12%)	4.53	4	0.34
C. Views on potential modifications to determination of test frequency																		
Include spike allowance	6 (15%)	25 (64%)	4 (10%)	3 (8%)	1 (3%)	5 (29%)	10 (59%)	2 (12%)	0 (0%)	0 (0%)	1 (5%)	15 (68%)	2 (9%)	3 (14%)	1 (5%)	11.8	4	**0.019**
Fixed number of tests	4 (11%)	6 (16%)	11 (30%)	14 (38%)	2 (5%)	3 (16%)	5 (26%)	5 (26%)	5 (26%)	1 (5%)	1 (6%)	1 (6%)	6 (33%)	9 (50%)	1 (6%)	2.01	4	0.734
Increase number of risk categories	1 (3%)	6 (16%)	12 (32%)	15 (41%)	3 (8%)	1 (6%)	4 (25%)	6 (38%)	5 (31%)	0 (0%)	0 (0%)	2 (10%)	6 (29%)	10 (48%)	3 (14%)	2.99	4	0.559
Decrease number of risk categories	0 (0%)	3 (8%)	15 (41%)	15 (41%)	4 (11%)	0 (11%)	2 (5%)	6 (11%)	7 (37%)	1 (37%)	0 (11%)	1 (11%)	9 (61%)	8 (11%)	3 (6%)	1.02	3	0.796

Table 4
Respondent opinion regarding current and future support available for implementing the LOI testing regime. Significant differences in responses between groups are highlighted.

Option	All					Group 1					Group 2					Chi-squared test Group 1 vs Group 2		
	Strongly agree	Agree	Neutral	Disagree	Strongly disagree	Strongly agree	Agree	Neutral	Disagree	Strongly disagree	Strongly agree	Agree	Neutral	Disagree	Strongly disagree			
	# (%)	# (%)	# (%)	# (%)	# (%)	# (%)	# (%)	# (%)	# (%)	# (%)	# (%)	# (%)	# (%)	# (%)	# (%)	X^2	df	P-value
A. Views on level of current support																		
Adequate support	1 *(3%)*	5 *(14%)*	9 *(26%)*	10 *(29%)*	10 *(29%)*	1 *(6%)*	0 *(0%)*	4 *(22%)*	7 *(39%)*	6 *(33%)*	0 *(0%)*	5 *(29%)*	5 *(29%)*	3 *(18%)*	4 *(24%)*	13.45	4	**0.009**
B. Views on potential modifications for enhanced support																		
Laboratory certification	20 *(45%)*	19 *(43%)*	3 *(7%)*	2 *(5%)*	0 *(0%)*	12 *(57%)*	6 *(29%)*	3 *(14%)*	0 *(0%)*	0 *(0%)*	8 *(35%)*	13 *(57%)*	0 *(0%)*	2 *(9%)*	0 *(0%)*	6.54	3	0.088
Provide more support	9 *(22%)*	26 *(63%)*	4 *(10%)*	1 *(2%)*	1 *(2%)*	6 *(32%)*	11 *(58%)*	2 *(11%)*	0 *(0%)*	0 *(0%)*	3 *(14%)*	15 *(68%)*	2 *(9%)*	1 *(5%)*	1 *(5%)*	3.52	4	0.474
Simplify guidance	7 *(18%)*	23 *(59%)*	7 *(18%)*	2 *(5%)*	0 *(0%)*	4 *(22%)*	10 *(56%)*	4 *(22%)*	0 *(0%)*	0 *(0%)*	3 *(14%)*	13 *(62%)*	3 *(14%)*	2 *(10%)*	0 *(0%)*	3.37	3	0.338
Independent sampling	16 *(37%)*	13 *(30%)*	7 *(16%)*	7 *(16%)*	0 *(0%)*	8 *(40%)*	3 *(15%)*	5 *(25%)*	4 *(20%)*	0 *(0%)*	8 *(35%)*	8 *(35%)*	4 *(17%)*	3 *(13%)*	0 *(0%)*	3.04	3	0.385
Tax breaks for investment	9 *(28%)*	12 *(38%)*	4 *(13%)*	6 *(19%)*	1 *(3%)*	8 *(47%)*	4 *(24%)*	1 *(6%)*	4 *(24%)*	0 *(0%)*	1 *(7%)*	8 *(53%)*	3 *(20%)*	2 *(13%)*	1 *(7%)*	7.94	4	0.094
Process endorsement	6 *(17%)*	9 *(26%)*	3 *(9%)*	9 *(26%)*	8 *(23%)*	5 *(26%)*	7 *(37%)*	2 *(11%)*	4 *(21%)*	1 *(5%)*	1 *(6%)*	2 *(13%)*	1 *(6%)*	5 *(31%)*	7 *(44%)*	8.86	4	0.065

guidance was clear and that it was the responsibility of the operator to understand and comply with all relevant legislation. While this statement of responsibility is indeed correct, it overlooks the key concern raised by multiple respondents that HMRC was not able to provide assistance when asked for clarification regarding the interpretation of the QFO.

The majority of respondents agreed that simplified guidance and a simplified process would be helpful. For example, respondents suggested that the LOI testing regime could be absorbed into the pre-acceptance checks, thus making these checks less subjective, and alleviating the perceived unfair responsibility placed on landfill operators to determine the correct tax rate. While pre-acceptance checks, transfer notes and visual inspections are all used to determine tax rate, as one respondent commented, the landfill operator is heavily reliant on the information provided by the producer, and is therefore reliant on the producer "being both truthful and being able to ensure operatives comply with operating procedures each and every day."

Two thirds of respondents supported the introduction of third party sampling. Respondents who disagreed noted that it would increase costs and timescales. While one respondent insisted that self-sampling was efficient, they also acknowledged that it is open to abuse. Another commented that there is no need for the extra cost burden "as long as the fines are taken to a standardised/accredited Lab and there is the full flow diagram, photo's etc. to support the production process".

LOI test standardisation and laboratory accreditation was the most strongly supported proposal, reflecting the concerns raised throughout the survey regarding the accuracy of the testing regime. Respondents noted this would negate issues concerning margin of error between laboratories and address issues related to the fixing of results. It was also suggested that test providers develop the testing regime so that it addresses concerns relating to accuracy and reliability, where evaluation of the actual margin of error across all (accredited) testing providers could be incorporated into a reframing of the LOI limit (i.e. 10% ± margin of error).

Two thirds of respondents supported the introduction of tax breaks for new technology. While one respondent commented that tax breaks were unnecessary and that technology should be financed through reduced tax liability, earlier responses from group 1 highlighted that uncertainty (in producing fines that qualify for the lower rate of tax) creates barriers to future investment.

Overall, there was a broadly even split between those who supported and opposed process endorsement, where the majority of group 1 were supportive and the majority of group 2 were opposed. One respondent suggested that HMRC should approve processes in combination with third party sampling, with analysts from independent laboratories employed to take random, unannounced samples. However, another respondent (who strongly disagreed) suggested that the focus should be on how inputs influence fines composition. This suggests that the lack of support for process endorsement may at least partly reflect differing interpretations of what that would entail, as a waste separation process is typically designed for a specific input stream. Nonetheless, the point that inputs exert the primary control on the composition of the resultant fines is valid, and if process endorsement were to be pursued, actual inputs must be taken into account.

4.6. The QFO may act as a barrier to investment

This research has found that the QFO may act as an unintended barrier to investment in future waste processing, thereby acting contra to the intended goal of the LFT to promote landfill diversion and the more recent policy imperative to enhance material recovery. Due to the low value of separated materials, the financial viability of processing can be poor leading some operators to consider closing existing sorting stations, particularly when anticipated tax savings are not fully realised. Furthermore, uncertainty concerning the accuracy and reliability of the LOI testing regime may negatively impact decisions regarding the type

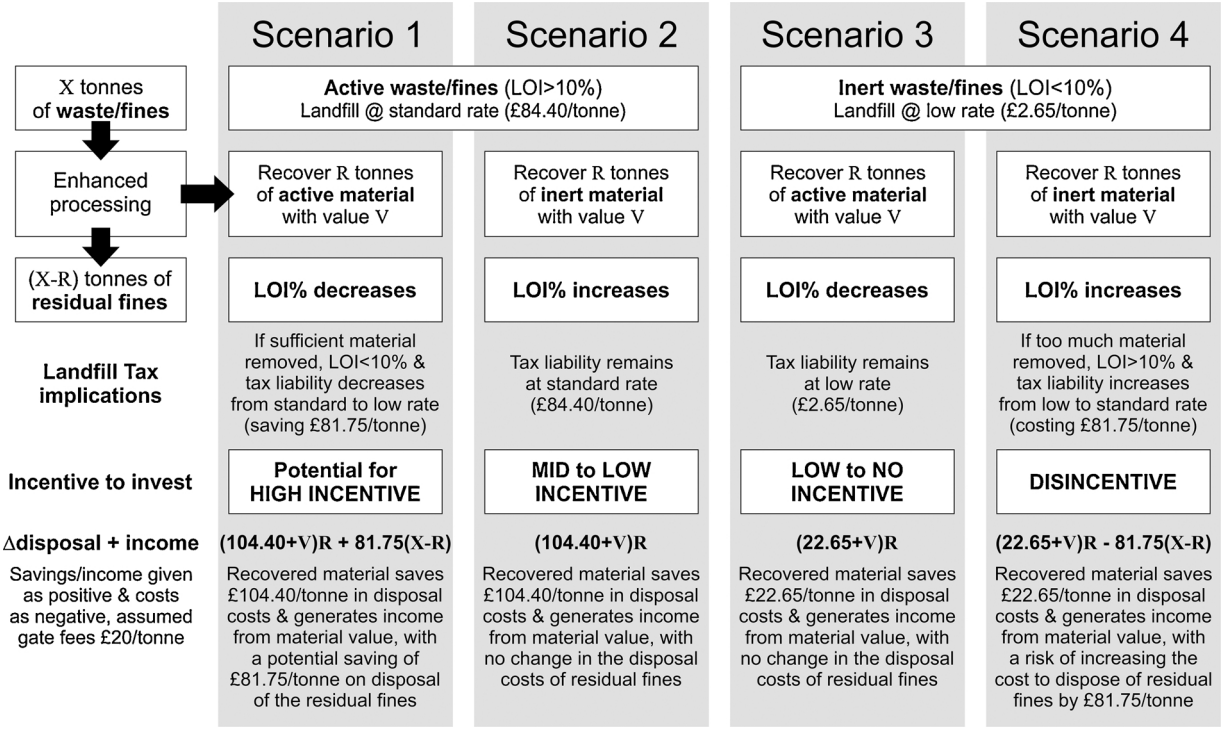

Fig. 3. Level of (dis)incentive to invest in advanced processing of fines taking into account current landfill tax implications of both the input waste and the residual fines.

and level of investment required for advanced processing.

Theoretical scenarios under which the QFO may influence landfill diversion are illustrated in Fig. 3. In scenario one, active wastes have the potential to achieve inert classification after advanced processing to remove active material. This provides the greatest potential incentive for investment due to benefits arising from the significantly decreased disposal costs (reduced tonnage and tax liability of residual fines), in addition to the value of the separated material (expected to be low). However, this incentive depends on the ability to generate a residual fine with 10% LOI or less. In scenario two (removal of inert material from active waste), financial benefits arise only from the reduction in tonnage disposed and the value of the separated material, thus providing a reduced incentive for investment. In scenario three (removal of active material from inert waste), the financial benefits are further reduced due to the original low disposal costs, providing little to no incentive for advanced processing. In scenario four (removal of inert material from inert waste), there is a strong disincentive for further materials recovery due to the risk of residual fines exceeding the 10% LOI limit resulting in significantly increased disposal costs.

These scenarios clearly illustrate the shortcomings of applying a sharp boundary between two disparate tax rates at the somewhat arbitrary 10% LOI threshold. Modifying the tax to one based on multiple bands or a sliding scale has the potential to address this issue, strengthening the incentive for advanced processing in all cases except when the LOI of the original material is marginally greater than 10% and the removal of a small amount of active material would currently trigger a substantial saving. Amalgamating the various proposals put forward by respondents suggests some form of gradation in intermediate tax rates between 5% and 20% LOI would incentivise further separation and alleviate industry concerns that the current tax regime is punitive with a greater focus on revenue generation than environmental protection. This could be strengthened by combining taxation with direct incentives for investment, particularly in cases where the projected return is low or negative, and could potentially be achieved through recycling tax revenue to provide an enhanced capital allowance on 'resource efficient technologies', as is currently available in the UK for a range of energy and water efficient technologies.

4.7. Clarity is needed regarding responsibility for fines classification and LOI testing

A number of issues regarding the implementation of the QFO with respect to the relative responsibilities and liabilities of key stakeholders were raised. This included the perception that the test regime is vulnerable to abuse and concerns over uncertain costs at time of disposal.

At present, the waste processor is required to correctly describe and classify fines, where it is the responsibility of the landfill operator to verify the description, complete an LOI test if necessary, and ensure the correct tax rate is applied. It was suggested that this leaves the landfill operator vulnerable to unscrupulous waste processors (through provision of an incorrect description), and the system vulnerable to unscrupulous landfill operators (if results are manipulated), where there was a perception that the system is virtually unpoliced, with minimal compliance checks taking place.

In addition, due to the time required to complete an LOI test (up to three weeks) a situation may arise where fines are accepted for disposal as inert and are later reclassified as active. This risk of change in tax liability introduces uncertainty into the business models of waste processors and landfill operators, and with respect to the former may create a barrier to investment. Furthermore, a failed test result would require subsequent loads to be tested, where these may already have been landfilled in the time taken to evaluate the earlier load. Such situations cased the current regime to be described as unworkable.

Absorbing the LOI testing regime into pre-acceptance checks could provide a solution and would align with other established methods of classification. For example, to determine hazardous status of a waste, the material is tested at least twice a month against sixteen (hazardous) properties before it can be moved, disposed of, or recovered (Environmental Agency EA, 2015). Determined on a 24-sample rolling basis, the material is deemed hazardous if more than five properties exceed the relevant limit or if one property limit is exceeded four times or more (Environmental Agency EA, 2015). Employing routine testing

where classification is determined on a rolling-basis would provide a greater level of certainty regarding fines classification prior to disposal, with the responsibility of correct classification squarely placed with the producers. Furthermore, it could be argued that this would better represent the fines being produced over time and be more consistent in classification.

4.8. The LOI test regime is currently not fit for purpose

Meaningful discussions regarding the operational procedures of the QFO are contingent upon an LOI test regime that is fit for purpose and adequately represents the characteristics of qualifying fines. With regard to the latter point, while the use of LOI as a sole measure of environmental burden was questioned, it is noted that it does reflect a key driver of landfill diversion (GHG emission reduction) and it is the authors view that immediate priority should be given to improving the LOI test regime.

Throughout the survey, respondents repeatedly emphasised that the LOI test is severely limited, being both inaccurate and imprecise. The validity of a standardised test is dependent on the reproducibility of results, both within and between laboratories (Geurts et al., 2016). While LOI is often used in soil analysis due to its simplicity and cost-effectiveness, it is generally considered to provide only a crude indication of organic content where test accuracy is known to be affected not only by the sample clay content, but also by a range of procedural details (Hoogsteen et al., 2015; Wang et al., 2011). In addition to the inherent limitations of the test and the failure of the QFO to specify key procedural parameters (thereby leaving it open to interpretation by different test providers), the method and frequency with which samples are obtained has also been criticized for being open to bias and failing to represent the material being landfilled. These limitations could be mitigated by developing a stringent test regime, with little or no room for interpretation, accrediting test providers, and employing third party independent sampling.

5. Conclusions

For waste policy to be effective, particularly in the context of driving the transition to a CE, it should be balanced; providing the correct amount of sanction and incentive to enhance resource recovery while ensuring innovation and investment in progressive waste management strategies is not stifled. Employing a stakeholder-oriented approach, this study has illustrated an example of un-balanced policy, where secondary legislation (the QFO) introduced to address a specific issue (fines classification) has had an unintended negative impact on the principal aim of the primary legislation (the UK LFT) to increase landfill diversion. Specifically, we find that the QFO has created a perverse incentive to decrease landfill diversion through limiting the recovery of secondary materials (underpinning principle of CE) and discouraging investment in technology (required for transition to CE).

While this study found a number of stakeholder dissatisfiers had undermined implementation of the QFO, most notably the complexity of (and missing details in) the QFO guidance and a perceived lack of support from (an unknowledgeable) HMRC, the most critical factors identified were related to policy design. Here, the process for determining the classification of fines and the discontinuity in disposal costs were both identified as major weaknesses with negative impacts on environmental protection, profitability, and investment in technology. These findings highlight both the importance of policy coordination when multiple constraints are present, and the insights that stakeholders can provide (while acknowledging that these will inevitably reflect vested interests) regarding the design and implementation of market-based policy instruments.

With respect to the classification of fines, the current process was found to be open to interpretation and abuse (leading to variation in and misclassification of fines), and was viewed as unworkable and unfair. This arose from a division of responsibility between the producer and the landfill operator, an apparent lack of compliance checks, the time lapse between load delivery and receipt of LOI test results, and a poorly described LOI test regime that is open to sampling bias, lacks methodological details and fails to take account of the inherent limitations of LOI testing. With respect to the discontinuity in disposal costs, the sharp boundary in tax rates at the 10% LOI threshold was not only found to be a blunt instrument for promoting landfill diversion, but one which actively dis-incentivises material recovery leading to a cessation in current separation practices and acting as a barrier to investment in new separation technologies.

To address these issues, the following recommendations are made. First, priority must be given to the development of a robust LOI test method with fully defined operational parameters. This should include an assessment of reproducibility within and between testing laboratories in order to determine an appropriate measurement tolerance that can be taken into account when classifying fines for tax purposes. Second, it is recommended that the balance of responsibility for fines classification is shifted to the waste processor, with LOI determined on a rolling basis and incorporated into pre-acceptance checks (similar to hazardous waste classification). Sampling frequency should be based on risk categories that reflect the composition of input wastes, the processes employed, and the consistency of LOI test results, with third-party sampling and/or regular compliance checks to protect the system from abuse. Third, the 10% LOI threshold should be replaced by multiple tax bands or a sliding scale and ideally would be combined with a direct incentive for investment such as an enhanced capital allowance for resource efficient technologies. At a minimum, it is imperative that the current strong disincentive for recovering inert material is redressed.

As a final note, it is emphasised that explicit consideration must be given to the interaction between environment and technology during the policy design process in order to ensure that the continued evolution of waste management policy is effective.

Declaration of interest

None.

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Appendix A. Supplementary data

Supplementary material related to this article can be found, in the online version, at doi:https://doi.org/10.1016/j.resconrec.2018.07.011.

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